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Manuscript ID:
IJWGAFES-2026-030705

DOI: 10.5281/zenodo.23410393

DOI Link:
https://doi.org/10.5281/zenodo.23410393

Volume: 3
Issue: 7
July
Year: 2026
E-ISSN: 3066-1552

Submitted: *07 June 2026*

Revised: *12 June 2026*

Accepted: *12 July 2026*

Published: *31 July 2026*

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How to cite this article:
Gangurde, P. C. (2026). Soil-Settlement Relationships in Nashik: Analyzing the Role of Pedology in Rural Development. International Journal of World Geology, Geography, Agriculture, Forestry and Environment Sciences, 3(7), 23–29. https://doi.org/10.5281/zenodo.23410393

Soil-Settlement Relationships in Nashik: Analyzing the Role of Pedology in Rural Development

Dr. P. C. Gangurde

Abstract

This paper tries to examine the interrelationships between soil types and spatial distribution of villages in Nashik district which is marked by multiple physiographic units like Godavari valley, Sahayadri hills, plains, western ghats and Deccan plateau. The soils of the District can be broadly classified under six types namely- Deep black, medium black, shallow black and brown red and yellow, laterite and lateritic soils which are mainly basalt weathering soils. These soils have significantly physical and chemical attributes, that are concerning the settlement patterns and agriculture potentials. About 60.41% of rural settlements are located on fertile black soils occupying 68.83% of the area. The soils contain a large proportion of water holding capacity and it contains plenty of alumina, calcium, magnesium carbonates and potash which are suitable for high value crops such as grapes, sugarcane, cotton, banana, onion, vegetables etc. under intensive farming. The productivity in agriculture promotes dense and nucleated settlements focusing mainly in medium to large size and located in central, eastern and southern part of Nashik, which achieves modern housing and organized layouts. However, brown, red and yellow (laterite and lateritic soils) cover 31.17% of the district, whereas 40% of the rural settlements rely on these soils. They are mostly located in the heavy rainfall zones in ghoti terrains of west India, are less fertile, highly susceptible to erosion and crops like paddy, black gram, Nagali and groundnut are grown in them. Small, fragmented and dispersed settlements here are typical of small population carrying capacity and may be home to tribal groups. The t-value of the regression analysis was very high (10.3858), the R^2 value was 96.42% and there was a strong positive correlation between soil type area and the rural settlement numbers, highlighting the niche role of the area in the soil of distributing settlement in the study area. Most of the settlements are medium and very large in black soil areas, and mostly at the tiny and small level of the settlements in other soil type areas. The results further emphasize the need for pedology in the context of rural development, and to ensure sustainable planning of settlements and agricultural policies in the city of Nashik, soil characteristics should be taken into consideration.

Keywords: *Soil types, rural settlements, Nashik district, black soils, lateritic soils, settlement patterns, regression analysis, pedology, rural development.*

Introduction

Physiographic and pedological features vary in the western parts of Nashik district which have different distribution and development of rural settlement. The region encompasses significant physiographic features like Godavari Valley, Eastern plains, Satmala range, Selbari range, Dolbari range (Extensions of Deccan Plateau), Western Ghats. All the above factors have influenced agrarian conditions and settlement within the district because of its complex topography, river systems which include Tapi and Godavari basin and diverse environmental conditions. The soils of Nashik district form part of predominantly basaltic parent material type is divided into six major groups, viz. deep black, medium black, shallow black, brown-red-yellow, lateritic and laterite soils. The physical and chemical properties of these soils vary and have a significant impact upon agricultural potential and the distribution of human Settlement. Black soils account for 68.83% of the area of the district and have good fertility and moisture holding capacity making them highly productive. They are suitable for commercial crops like grapes, cotton, sugarcane, banana and vegetables and have their irrigation facility, which has encouraged intensive farming in regions like Niphad, Dindori, Sinnar, Nashik, Kalwan, Baglan and Malegaon. These regions thus results in higher and denser rural populations. On the contrary, brown, red, yellow, lateritic and laterite soils are around 31.17% of the district mainly in western hilly parts in the district with high rainfall and rugged topography in densely forest areas. The soils are less fertile and are very prone to erosion and suitable crops grown on them are paddy, Nagali, black gram and groundnut. The extremely harsh physical landscape has led to smaller, far-flung communities – especially tribes. The spatial link between soil properties and settlement patterns emphasises the importance of environmental resources that exert a huge impact on human settlement.

High agricultural productivity and settled population is identified in areas of fertile soils that are contrasted with areas of less productive soils and dispersed settlement. The positive correlation of soil distribution and settlement pattern, substantiates the role of pedological factors to be of great importance in explaining rural geography of the Nashik district. Knowing these interactions is crucial for sustainable development of rural areas, for resource planning and an environmentally balanced development.

Objectives

The study aims are to analyze the spatial distribution of rural settlement according to a various soil type of Nashik district.

1. To classify and delineate the dominant soil types in Nashik district based on physical properties and chemical properties of soils.
2. To study the effect of agricultural potential (soils) on size, density and location of rural settlements.
3. To statistically measure the relationship between area of soil type and rural settlements with statistical methods.
4. To investigate the implication of the pedological factors with a view of sustainable rural development and settlement organization of Nashik district.

Data Sources

1. Soil maps and classification data obtained from studies of soils formed from basalt weathering and pedological surveys throughout the region in Nashik district.
2. Census and administrative records that document rural settlement location, size and population.
3. Relevant statistics of Agricultural Land use and Crop Pattern (suite).
4. Topographic Maps and physiographic maps on the Western Ghats, Deccan Plateau, Sahayadri hills areas, plains and Godavari valley areas of the district.

Methodology

1. Soil Classification: Determination and classification of soils as per the six major soil classes, deep black, medium black, shallow black, brown red and yellow, laterite and lateritic from the existing pedological surveys based on soil physical and chemical properties.
2. Spatial Analysis: Mapping of villages in Nashik district using the spatial tool GIS software and identifying the linkages amongst the occurrence of various soil and physiographic zones as well village.
3. Agricultural Assessment: Assessment of crop patterns and agricultural productivity of each soil type based on secondary agricultural information and field observations.
4. Statistical Analysis:Determination of R^2 and t-values of the testing in order to ascertain the strength and significance of relation between area of each soil type and rural settlements with the help of regression analysis.
5. Settlement Size Categorization: categorization and analysis of settlement size, and distribution of settlement size by soil type to understand settlement pattern. Interpretation: Interpretation of soil fertility, topography, rainfall and socio-economic factors to facilitate planning of rural development, settlement distribution.

Study Area

The study has been conducted in the Nashik district because of its unique geographical and socio-economic features. Nashik is situated in north west of Maharashtra and lies within the two basins – the Godavari river and the Girna river. Geographically, it extends from 19˚33' to 20˚53' north latitude and 73˚15' to 75˚16' east longitude (Nashik Gazetteer, 1983), and is mapped by the Survey of India on degree sheets 46H, 46L, 47E, and 47I. Located on the leeward side of the Western Ghats, Nashik is one of Maharashtra's more developed and populous districts, excluding its tribal regions. Encompassing an area of 15,530 square kilometers, the district comprises a wide variety of landscapes, with elevations ranging from 300 meters to over 1,200 meters. It contains 1,922 rural settlements, reflecting its diverse topography and socio-economic framework. These characteristics render Nashik an ideal area for studying the spatial distribution and growth of rural settlements.

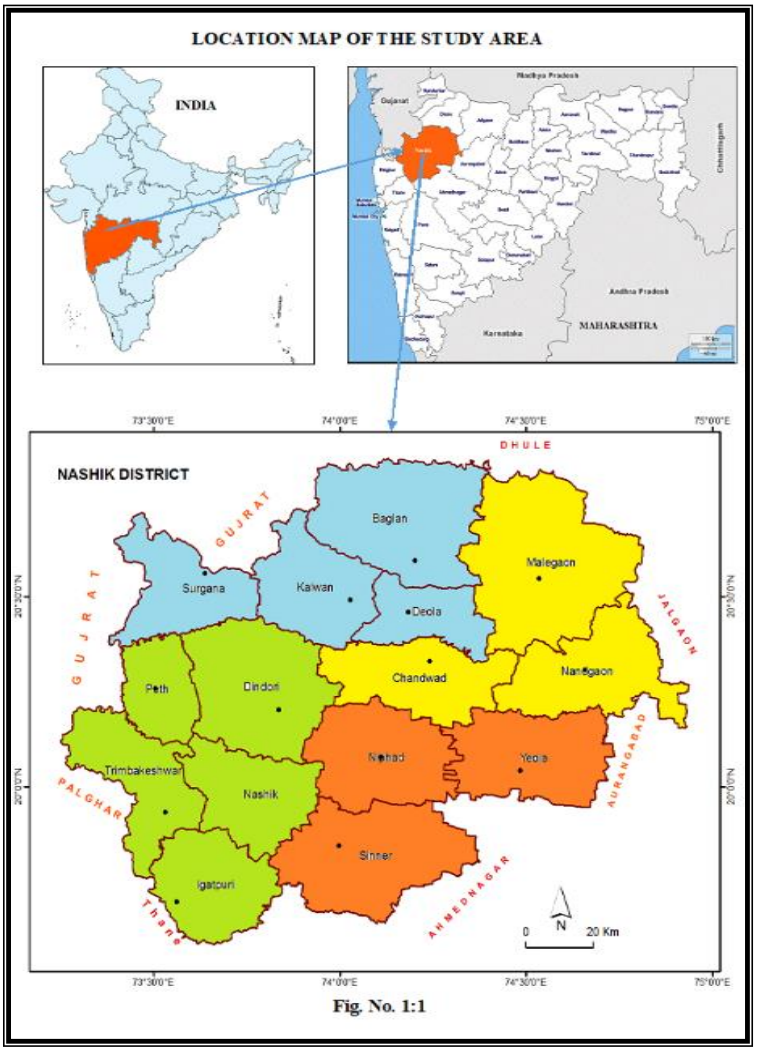


Fig. No. 1:1

Discussion

The study identifies the soil types as playing significant role in the rural settlements formation and also reveals the spatial distribution and properties of rural settlements of Nashik district. There are strong correlation between settlements number and soil area, backed statistically, which reflects soil fertility as one of the seminal factors for rural settlements. Fertile black soils, laterite soils with good water holding capacity and fertility have potential for high value crops and medium to nucleated settlements with good infrastructure. Lateritic and brown soils are found in high rainfall and hilly regions are less fertile, vulnerable to erosion and are characterized by smaller and dispersed settlements, predominantly tribal, with lower agricultural potential and lower land carrying capacity.

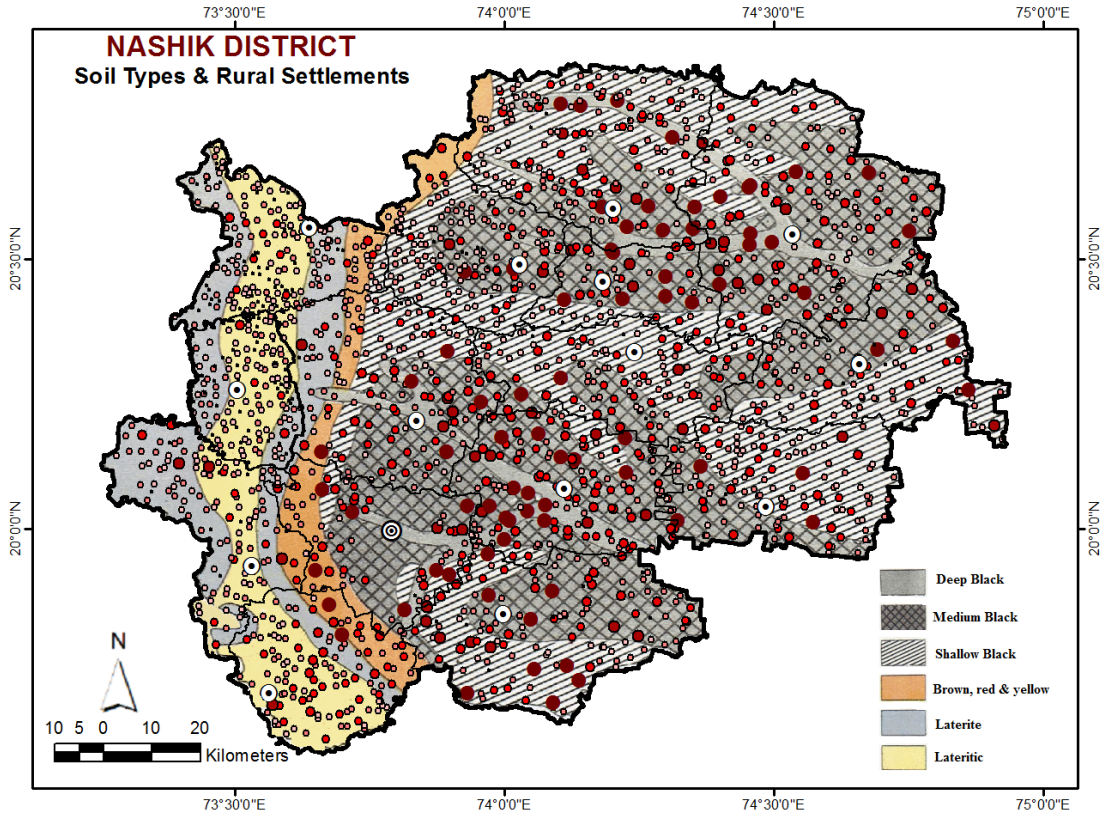


Fig. 1.2

The spatial variation of settlement distribution is indicative of a complex interaction between pedological conditions, topography, climate and socio-economic conditions and is a reflection on the rural development potential. The paper's combination of the physiographic and agricultural data gives a full picture of the influence of the environment on settlement geography. The observed facts underline the need to consider and include in rural planning and development at regional level the soil matrix as an integral part to facilitate sustainable land use and maximise soil productivity. Therefore, future planning of settlements in line with pedological realities can be helpful for the betterment of supporting rural sources of livelihoods and resource management in Nashik district.

The table I:1 shows the soil type, no of rural settlements and their percentage of rural settlements in the study region.
Table No. I: 1

Soil Types, No. of Rural Settlements and its Percentage

Sr. No.	Type of Soil	The area in Sq. Km.	Area %	Number of Rural Settlements	Percentage
01	Deep Black	1048.87	06.87	209	10.87
02	Medium Black	4810.00	31.52	500	26.02
03	Shallow Black	4645.00	30.44	452	23.52
04	Brown, Red & ellow	984.00	06.45	170	8.84
05	Laterite	1924.20	12.61	300	15.61
06	Lateritic	1848.20	12.11	291	15.14
	Total	**15260.27**	**100.00**	**1922**	**100.00**

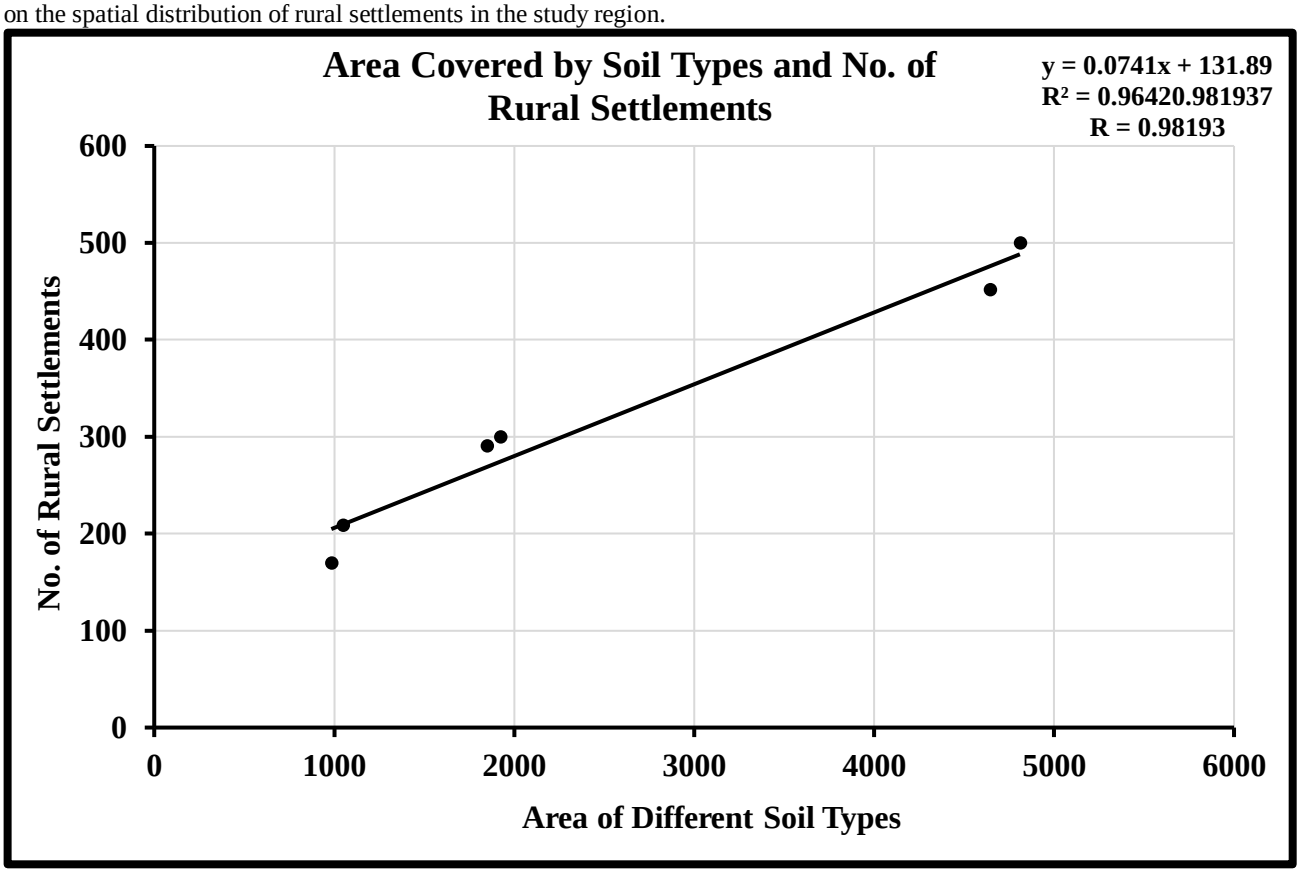
Source: Compiled by the researcher

The eastern, central and southern parts of the Nashik district have deep soil, Medium black soil and Shallow black soil, respectively. They cover nearly 2/3 (68.83 per cent) of the study area; and 60.41 per cent rural settlements are located within the study area. These soils are fertile having high water holding capacity, well suited for the prosperity of agricultural activities. Black soils along with irrigation facilities, lead to the development of irrigated farming in these soil belts. Due to the high carrying capacity of the land, attracts compact medium to large size settlements and hence about 1161 rural settlements are unevenly distributed in the study region. These soils are well suited for growing of grape, sugarcane, cotton, banana, onion and vegetables. The farmers belong to these black soils, have high income and hence the settlements are handled together, as a result, the houses having modern architectural styles are grown in the compact settlements. The fourth soil type was the rural area, Brown, Red and Yellow soils less fertile with the main occurrence to the west of Nashik district covered 984 sq. km. (i.e. 6.45 percent). They live in Satana, Kalwan, Dindori and Nashik and eastern part of the Surgana, Tryambkeshwar and Igatpuri tehsils of the study area.

All these tehsils only 170 rural settlements i.e. 8.84 percentage to the total rural settlements are located. For these tehsils, the primary crop is paddy and other crops are grown such as black gram, Nagali and Groundnut. The laterite soil is occupied about 12.61 percent area of the study region. Which covers Surgana, Peth, Tryambkeshwar and eastern part of Igatpuri tehsils. In this soil belt, 300 rural settlements account 15.61 percent to the total rural settlements are unevenly distributed. The lateritic soil type is mainly observed in the central part of the Surgana, Deola, Tryambkeshwar and Igatpuri tehsils of the Nashik district. This soil covers 12.11 percent of the terrain and there are 291 rural settlements (incoming 15.14 percent) in the study area. This soil belt is typified mostly by tiny and small size units especially small dispersed settlements. The lateritic soil belt is mainly found in the heavy rainfall zone characterised by hilly, undulating surface, dense forest, a limited cultivated land, inaccessible and resided by the tribal community, the land is too poor to support large compact settlements and mixed copping and farming leads to fragmented settlements.

The regression equation is therefore calculated and line of best fit drawn depicting the generalisation of the relationship, which shows the general rate of change of these two variables (soil type area and rural settlements). The regression equation is y=0.0741x+131.89. In this regression equation, it is concluded from this that there would be 0.0741x+131.89 rural settlements with an average for each tehsil in the study area for every 100 xkm² of soil type area. Coefficient of determination is at around 0.9642 which means the area occupied by the soil types of Nashik district contributes toward explaining 96.42 per cent of the rural settlements. So type thus, also affects the settlements of rural areas.

The results suggest that there is positive relationship between the two variables. The 't' test is used to test this degree of freedom. From the following, it is seen that the calculated 't' value = 10.3858, and that the table values of 't' with 4 degrees of freedom, corresponding to 5% and 1% level of significance are 2.77 and 4.60, respectively. The calculated value is strongly significant as compared to the table values and thus the alternative hypothesis that there exists a significant correlation between these two variables is accepted. Therefore, the area occupied by different soil types has a great influence on the spatial distribution of rural settlements in the study region.



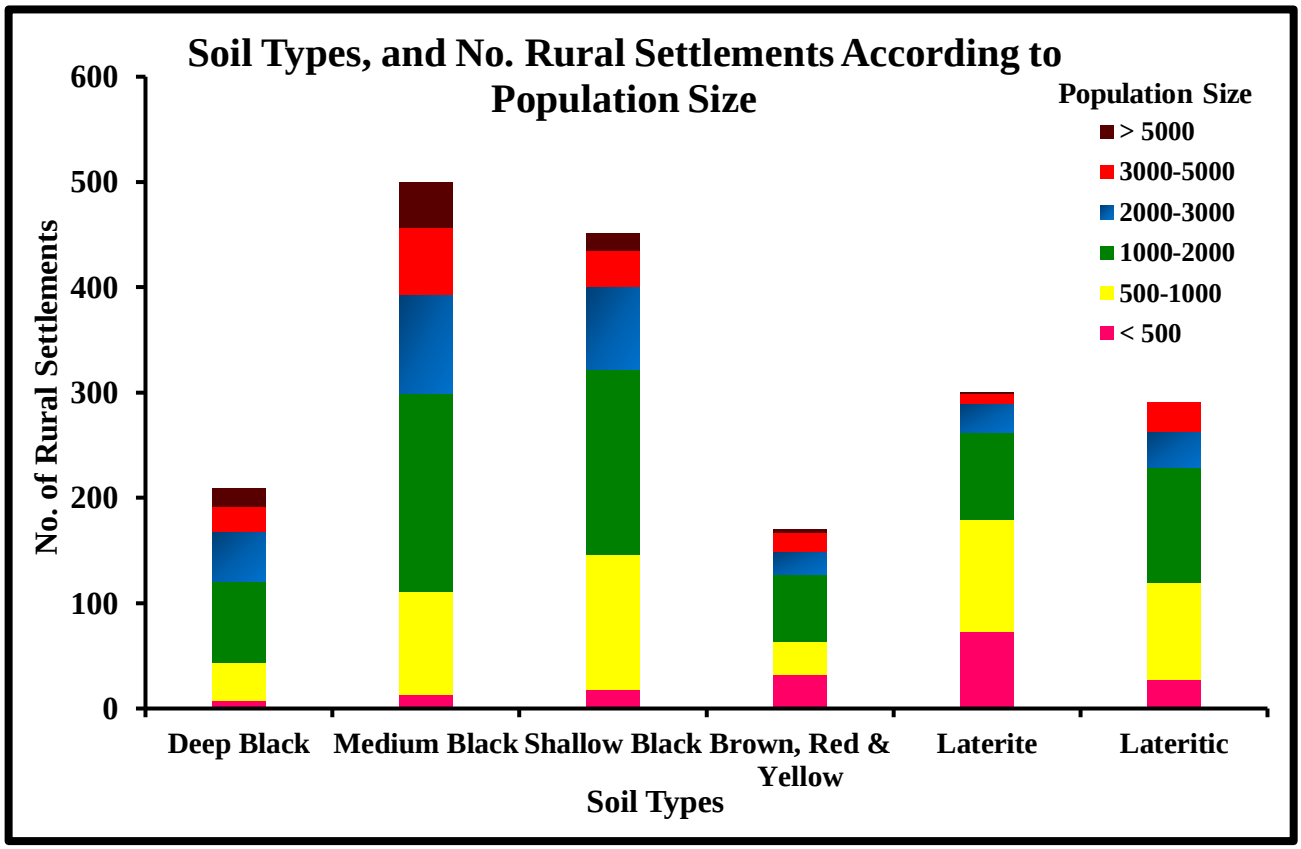
Graph No. I: 1

Table No. I: 2 Different Soil Types and No. of Rural Settlements (According to Population Size)

Sr. No	Soil Type	< 500	500-1000	1000-2000	2000-3000	3000-5000	>5000	Total
1	Deep Black	07	37	77	47	23	18	**209**
2	Medium Black	13	98	188	94	64	43	**500**
3	Shallow Black	18	128	176	78	35	17	**452**
4	Brown, Red & Yellow	32	31	64	22	18	03	**170**
5	Laterite	73	106	83	27	10	01	**300**
6	Lateritic	27	92	110	34	28	00	**291**
	Total	**170**	**492**	**698**	**302**	**178**	**82**	**1922**

Source: Compiled by Researcher

Table no. I: 2 clearly indicates that different soil types and their respective number of the rural settlements in each population size. There are six categories of soil types namely, deep black soil, medium black, shallow black, brown, red and yellow, laterite and lateritic soil in the study region. The quantitative analysis of the rural settlements is depicted in graph I:2.



Graph No. I: 2

The rural settlements of the study area are concluded to be in deep black soil belt, medium black soil belt and shallow black soil belt are about 60 per cent of the rural settlements in the study area. It is also observed that most of the settlements are categorized as medium, large size and very large during the field survey while a very few settlements are categorized as tiny and small size. All these settlements are nucleated because of favourable environmental conditions leading to intensive cultivation which is also conducive to the concentration of settlements. Laterite/latitic soils occur in areas of high to heavy rainfall coupled with hilly regions and the soils have lower fertility and fertility potential. On the other hand brown, red and yellow, laterite and lateritic soils are common in the more or less flat areas of the region with less rainfall. So, as a result, there are nearly 40 per cent rural settlement distributed in such a way that these are not evenly covered in these soil belts. The majority of settlements are small and tiny/ small size dispersed settlements. Only four large size settlements are developed in this soil belts—very large in size. It indicates that such areas are not particularly conducive to large size nucleated settlements.

Summary

This study explores the relationship between soil types and the distribution of rural settlements in the Nashik district of India. The district has diverse topography and six soil categories: lateritic, laterite, brown red and yellow, shallow black, medium black, and deep black. The study reveals that deep, medium, and shallow black soils, which occupy about 68.83% of the area, support 60.41% of the rural settlements due to their fertility and irrigation facilities, leading to intensive cultivation and compact, medium to large-sized settlements. In contrast, brown, red and yellow, laterite, and lateritic soils, found in hilly areas with high rainfall, are less fertile and support only 40% of the rural settlements, which are predominantly tiny and small-sized dispersed settlements. A regression analysis shows a strong positive correlation between soil type area and the number of rural settlements, with a coefficient of determination of 96.42%, highlighting the significant influence of soil types on the spatial distribution and characteristics of rural settlements in the Nashik district.

Acknowledgement

I express my sincere gratitude to all those who have contributed directly or indirectly to the successful completion of this research paper entitled “Soil-Settlement Relationships in Nashik: Analyzing the Role of Pedology in Rural Development.” I am deeply thankful to my institution, MVP Samaj’s S.V.K.T. Arts, Science & Commerce College, Lam Road, Deolali Camp, Nashik, for providing the necessary academic environment and support for undertaking this study.

Financial support and sponsorship

Nil.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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